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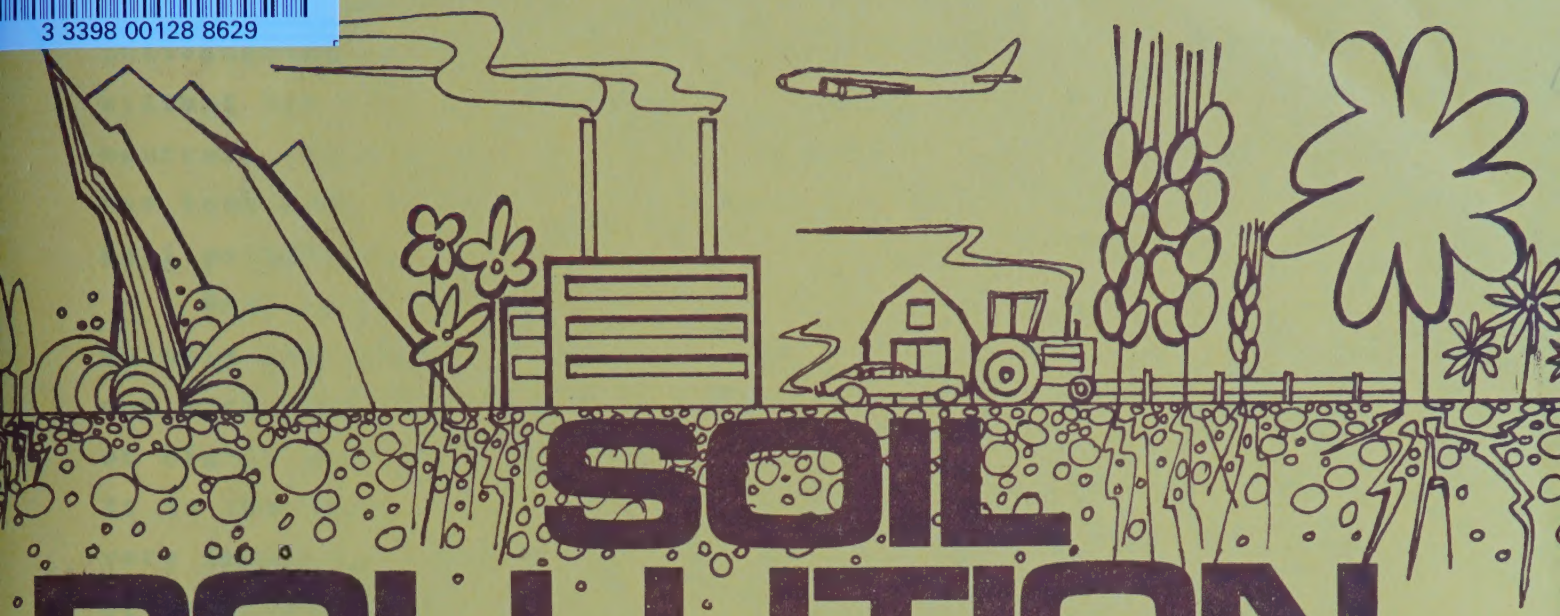

SOIL POLLUTION IN ALBERTA

PROVINCE OF ALBERTA
THE ALBERTA DEPARTMENT OF AGRICULTURE.
H. A. RUSTE, MINISTER
E. E. BALLANTYNE, DEPUTY MINISTER

SOIL POLLUTION

Introduction

The purpose of this leaflet is to provide a brief introduction to the complex topic of soil pollution. No attempt has been made to adequately cover all aspects of sources, their extent or solutions to problems. An attempt has been made to place in perspective the various aspects of soil pollution.

Soil is the essential link in the food chain of humans, animals and plants. The world's soil resources are limited and with increased population and urbanization, large acreages of highly productive land are taken out of production annually. It is therefore imperative that we protect and conserve this very important natural resource. Erosion and contamination of soil reduces productivity, sometimes temporarily, other times permanently.

Soil is a remarkable resource. It can accept and decompose vast quantities of waste and pollutants of many kinds without detrimental effects. The problems associated therefore, with soil pollution differ greatly in many respects from those of water and air pollution. Complex chemical, bio-chemical and biological reactions and processes occur in soils, which when properly handled could be utilized to dispose of many of our pollutants. However, these complex processes can be reduced or completely stopped when a pollutant is introduced which disrupts the physical, chemical or biological environment of the soil.

Soils consist of approximately 45% solid or mineral materials, 0.1% to 5% organic matter and 50% pore space filled with air and/or water. The relatively small portion by weight of organic matter is a highly reactive part of soil. Soil organisms (bacteria, actinomycetes and fungi) are potent agents of decomposition. They are indispensable (i) to mineralize plant and animal residues, (ii) to increase

availability to higher plants of minerals in inorganic combinations, and (iii) as an essential activity in the nitrogen cycle. Soil, therefore, may be used as a disposal medium for some types of pollutants, provided, however, the soil environment is not contaminated with some other more serious pollutants. Harmful pollutants may reach the soil from decaying vegetation that had been treated with a variety of biocides or from the air by industrial activity or by atomic explosions.

What is a Soil Pollutant?

A soil pollutant is any substance, either common or foreign to the soil system which, upon addition to the soil, either directly or indirectly adversely affects the productivity of the soil (crop yield and quality) and/or the drainage water from the soil. Since soil is not consumed by humans or animals, as is the case with air and water, there must be different criteria for measuring soil pollution. An adverse effect on the productivity or on the chemical composition of plants or on the composition of drainage water is considered and indication of soil pollution. Soil may be an air and water pollutant. Consider it in the atmosphere as a result of soil drifting caused by high winds. Erosion by water may make soil a water pollutant. Sand particles being large are not moved great distances by moving water or winds. Clay particles on the other hand may not settle out of the atmosphere or water until they are transported thousands of miles from their source.

Sources of Soil Pollution

There are three general sources of soil pollution in Alberta: (i) industrial activities, (ii) agricultural practices, and (iii) urban waste disposal practices.

Industrial Sources

1. Oil and salt water spillage during exploration and production of oil and natural gas--This was a problem in oil fields where large amounts of salt water were found. Salt water is now pumped into deep disposal wells. Salt water effects are more difficult to reclaim than oil spills. Salt water contains the element sodium which causes soils to deflocculate or lose their structure, thus leaching of the salt is very slow or ineffective. Salt is also toxic to plants at high concentrations.

2. Abandoned oil wells, flare-pits and battery sites-- In some oil fields, central pumping systems are being installed which result in the abandonment of a number of oil well battery sites. The spilled and burned crude oil can sterilize and prevent crop growth on land for a number of years. Reclamation of these areas is slow and expensive.

3. Sulphur Dust Loading at Gas Processing Plants--When solid sulphur is crushed and loaded on railway cars, sulphur dust may be blown to adjoining land resulting in an acid condition of the soil. The pH may drop to less than 3.5 whereas normal soil has a pH in the 5.0 to 7.5 range. Plant growth is usally very sparse below pH 5.0 and none will exist where it is less than 4.0. When sulphur is "chipped" for handling, the problem will be essentially eliminated. It is estimated that about 50-60 acres in Alberta are now affected to some degree by sulphur dust contamination.

4. Storage of Industrial Wastes and Disposal--Soil contamination can result from improper storage and/or disposal of chemical wastes. Dug-outs and burrow pits that are improperly located or un-lined results in seepage of chemicals to groundwater or to the surface of land.

5. Mining Overburden and Wastes--When coal mining overburden contains saline bedrock, as found in east central Alberta, the mining operator has considerable difficulty in obtaining satisfactory growth of planted grasses and shrubs. In the mountainous or foothill areas, improper coal mining may initiate serious erosion and silting of streams and rivers. Reclamation of these areas must be planned before mining operations bury valuable soil.

Agricultural Sources

There are six types of wastes from agricultural practices that could contaminate soil. These are:

i) biodegradable organic matter, eg. primarily manures, also crop residues;
ii) Disease organisms;
iii) Toxic chemicals, eg. pesticides and/or their decomposition products;
iv) Nutrients, excess fertilizer use or manure application.
v) Salts, natural minerals of water concentrated by cultivation and irrigation practices; and
vi) Soil itself, natural or man-abetted erosion.

The extent of soil pollution by these agricultural wastes or practices in Alberta is discussed in the following paragraphs.

There are very few results of tests showing the degree or extent of soil pollution since such research takes a lot of time and money and in many instances techniques or methods of analyzing such contamination are non-existent and must be developed.

Agricultural scientists are presently re-assessing past research and practices and where required are developing new techniques of analyses, or revising recommendations and practices to prevent contamination. New emphasis is being placed on present agricultural practices such as soil conservation to reduce or prevent pollution.

Since agriculture and forestry is practiced over large expanses of land, many not associated with these industries may believe that such practices cause extensive contamination of the environment. This may be true where abuses or mis-use is practiced, however there is legislation and regulation to control such practices. To name only a few: Soil Conservation Act, Noxious Weeds Act, Agricultural Chemicals Act, Public Health Act, Agricultural Pests Act, Forestry Act and the Public Lands Act. Many other acts and regulations of federal, provincial and municipal governments control practices on land or land use. One should keep in mind that every activity of man modifies or affects the environment to a greater or lesser degree. The degree of pollution which we are willing to live with or accept, is determined by the price in monetary funds, and human health and comfort.

I. Animal Manures -

Animal manures contain plant nutrients, organic matter and micro-organisims. At present, the most practical and beneficial method of disposal of this waste is application to land. A problem arises when improper storage, handling or field application allows these wastes to find their way into surface and groundwater. The addition of nutrients to waters may increase aquatic plant growth, which upon decay

utilizes dissolved oxygen in the water which is essential to fish and other aquatic life.

The addition of the degradable organic matter such as manure or run-off from feedlots is probably more serious than nutrient additions. Dissolved oxygen is utilized by the organisms that decompose such waste material when it is added to water.

Almost all animal wastes are applied to land as a fertilizer and soil amendment. Excess application of manures on land can also cause a build-up of nitrates in growing crops. Work is presently under way in Alberta to determine the extent of water contamination by this source. Alberta farmers are fortunate to have large tracts of land for disposal. In most instances, farmers never have enough to spread on all land that could effectively benefit from it.

II. Disease Organisms -

Although there are many water-transmitted diseases, agricultural wastes are far less likely to transmit disease organisms than are domestic sewages or other wastes. Wastes containing organisms should not be applied to crops which are eaten without cooking.

III. Pesticides -

The use of pesticides is necessary if agriculture is to produce the food needed to support the world's population. The problem is the development of pesticides that are effective for pest control, but not damaging to the environment. Pesticide manufacturers are constantly developing compounds that ever more closely meet this ideal, and farmers are doing a more careful and better job in utilizing them. Regulations controlling the use of pesticides are generally realistic and appropriate

for meeting the dual objectives of an unpolluted environment and an adequate food supply.

The two most common kinds of insecticides are chlorinated hydrocarbons, such as DDT, and organo-phosphates, such as malthion. Organo-phosphates are "timed-life" chemicals; i.e., even though they are initially usually quite toxic, they decompose rapidly in the environment and present no long-term residual problem. The chlorinated hydrocarbons such as DDT are much different; such compounds are refractory and decompose very slowly. Studies indicate that the chlorinated hydrocarbons are transported from agricultural fields as adsorbed material on eroded particles, such as clays and suspended organic material. The insecticide then remains in the water as a part of the turbidity or settles with the sediment to form a toxic bottom deposit in the lake or stream. The greatest use of pesticides in Alberta is in herbicides such as 2, 4-D and MCPA. About 65% of the cereal acreage is treated for weed control each year. Fortunately, the commonly used herbicides are short-lasting and decompose rapidly upon contact with the soil surface. Some damage may occur in cases where drift spray reaches susceptible plants or crops. This may be considered a type of pollution.

The amounts and kinds of pesticides used in Alberta is small compared to that used in other parts of Canada or North America. This, however, does not infer their use as unimportant. Pesticide use and application is under strict control with commerical applicators requiring qualifying licences.

There are no known cases of soil contaminated by pesticide use in Alberta. In many instances, the management or selection of crops or cultivation practices are effective in reducing the use of pesticides, eg. use of border strips on field to accumulate insects, thus alleviating need to spray large acreages.

IV. Fertilizers -

Fertilizers are chemical compounds which may contain nitrogen, phosphorus and/or potassium plus other plant nutrients such as sulphur. Fertilizers are used to supplement plant nutrients when the soil supply is inadequate during any or all of the growing season. Soils in Alberta generally have inadequate supplies of available nitrogen and phosphorus. The soil is a store-house of plant nutrients, most of which are available to plants rather slowly by mineralization. Total nitrogen content of a six-inch acre slice varies from one-half to over eight tons, however, plant available quantities range from nil to 60 or more pounds per acre (average 25 lbs./acre) depending on soil type, cultural practices, rainfall and other factors. Total phosphorus content can be as high as 2,000 pounds per six-inch acre slice while available quantities of phosphorus range from nil to 80 pounds per acre (average about 20 lbs./acre).

The Alberta Soil Testing Labroatory provides a testing service to farmers primarily for determining available quantities of plant nutrients in soil so wise and proper use of fertilizers is achieved. Although fertilizer use in Alberta has increased rapidly in the last 10 years, the total amount represents an average application of 13 pounds per acre of each of nitrogen and phosphorus (400,000 tons applied to over 14 million

acres). Fertilizers are one of the least expensive inputs in crop production from the standpoint of returns on investment. Fertilizer use in Alberta will always be limited for three reasons: (i) the most limiting factor to crop growth is a limited moisture supply (13 - 17 inches annually), and (ii) farmers always consider cost inputs at seeding time for seed, fuel, repairs and fertilizers, and fertilizer is the largest cost input at that time, and (iii) length of growing season (80-130 days). For these reasons farmers often tend to under-fertilize their crops. The risks of frost, drought and hail are high in Alberta.

Nitrogen - when nitrogen is applied, it is readily utilized by crops. Under Alberta soil and climatic conditions, little lateral movement or leaching of nitrogen beyond root depth takes place. Economics and risks involved prevents excess use. Even so, nitrogen application of over 800 lbs. per acre show no accumulation below a depth of 4 feet.

Nitrogen fertilizer application in 1968 (100,000 Tons) is equivalent to: (i) 13 lbs. per cultivated acre, or (ii) 40% of the total nitrogen removed (estimated 250,000 Tons of nitrogen annually) by cereal crops, or (iii) less than two-tenths of one percent of the total nitrogen supply in surface soils. It should be recognized that nitrogen fertilizer is not the only source of nitrogen in the environment. Nitrogen sources include natural geological deposits, atmospheric nitrogen in rain water or nitrogen fixed by legumes and nitrogen released by decomposition of crop residues, soil organic matter, animal wastes, etc.

Phosphorus - applied phosphorus is very insoluble and therefore very immobile in soil. It must be applied near the seed for efficient crops use. Phosphorus not utilized by plants is fixed by soil. Fertilizer phosphorus does not move through the soil to contaminate water. More

nutrients reach water by soil erosion than by leaching through soils.

V. Salts -

Generally, agricultural practices contribute little to the salt accumulation in soils or content in water. Natural leaching fron non-agricultural lands contribute much of the salts that rivers discharge into the oceans. Certain practices on irrigated and dryland farms can concentrate soluble salts in soils reducing and preventing the growth of many crops. It is estimated that 100,000 to 120,000 acres of non-irrigated land and 80,000 acres of irrigated land in Alberta is affected by salinity. Thus, this is perhaps the most extensive soil pollution problem in Alberta. Soil salinity is not all the result of man's activities as many acres were naturally saline before cultivation because soil parent material from which these soils developed were saline. Improved irrigation techniques including drainage, lining of canals and land reclamation are being conducted to reduce and prevent the problem.

VI. Soil Erosion -

Erosion and sedimentation are natural phenomena; such phenomena occurring in past geological ages formed today's rich agricultural cropland. But improper farming methods today speed the loss to top-soil from the land and eroded soil particles are pollutants in water and air. Studies of losses by erosion are limited in Alberta.

Wind erosion is the most serious problem, however many millions of acres are protected by using trash cover and strip cropping practices. Water erosion is most serious during spring run-off, especially in the central and northern parts of the province in years of large snowfall and rapid spring melt. Water erosion

from summer rains is not significant except in isolated locations, as Alberta does not normally experience intense rain storms. Silt deposits on lake bottoms are not considered as sources of phosphorus to aquatic plant life, in fact silts and clays on lake bottoms could fix phosphorus similar to fixation in soils.

Agriculture has an excellent record of conserving Alberta's soil resources. Continued education and incentive programs combined with regulations will prevent and reduce erosion losses.

Urban and Domestic Sources

Soil pollution could result from improper or inadequate handling and disposal of urban and domestic wastes. Disposal of these wastes are controlled by the provincial Department of Health and dumping wastes on land is not allowed. Approval must first be obtained to locate solid refuse (garbage) disposal sites with respect to soil and water contamination. Sewage disposal requires similar permission and surface disposal is not allowed. Some preliminary testing to utilize the waters from sewage plants as irrigation water is being conducted for a dual purpose: the use of water for increased crop production and as an effective final disposal method.

Summary

The purpose of this leaflet is to provide in brief some information on the broad and complex topic of soil pollution. It is also an attempt to place in perspective some aspects of activities affecting soil and land. It is not intended to include all possible sources or activities nor provide solutions to some of the present and future problems.

Additional Reading

1. "Agriculture and the Quality of Our Environment", N.C. Brady, Editor. American Association for the Advancement of Science. AAAS Publication 85, Washington D.C., 1967.

2. "Wastes in Relation to Agriculture and Forestry", C.H. Wadleigh, U.S.D.A. Misc. Publication 1065. Government Printing Office, Washington, D.C., 1968.

3. "The Pollution Reader" De Vos, Reason, Silveston, Drynan, Harvest House, Ltd., 1364 Greene Avenue, Montreal 6, Canada, 1968.

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